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Abstract

Background: International data show that the majority of children and youth are not sufficiently active. According to recent research, children who spend more time outdoors accumulate more daily moderate-to-vigorous physical activity and engage in less sedentary behaviour. However, the generalizability of these findings is uncertain, and few studies investigated whether outdoor time is associated with other physical and psychosocial health indicators.

Data and methods: This study examined associations between outdoor time and measures of physical activity, sedentary time, and physical and psychosocial health in a nationally representative sample of 7-to-14-year-olds (n = 1,159) who participated in the 2012/2013 Canadian Health Measures Survey. Physical activity and sedentary time were measured with Actical accelerometers. Direct measures of height, weight, waist circumference, grip strength, blood pressure, cholesterol, and glycohemoglobin were obtained. The Strengths and Difficulties Questionnaire was used to assess psychosocial health. Relationships between outdoor time and physical health measures were examined with multi-variable linear regression models adjusted for age, sex, parental education, and household income. Logistic regression models controlling for the same variables were used for psychosocial health.

Results: Each additional hour spent outdoors per day was associated with 7.0 more minutes of moderate-to-vigorous physical activity, 762 more steps, and 13 fewer minutes of sedentary time. As well, each hour outdoors was associated with lower odds of negative psychosocial outcomes (specifically, peer relationship problems and total difficulties score). Outdoor time was not associated with any of the measures of physical health.

Interpretation: Children reporting more time outdoors are more active, less sedentary, and less likely to have peer relationship problems, compared with those who spend less time outdoors.

Keywords: Accelerometer, child development, exercise, mental health, motor activity, outdoor play, physical fitness

International evidence consistently shows that the majority of children and youth are not sufficiently active.[1-4] This is often described as a physical inactivity crisis[4,5] because, even at young ages, low physical activity is associated with the clustering of cardiovascular disease risk factors.[6,7] Furthermore, population-based studies have reported that more than half the waking hours of children and adolescents are spent engaging in sedentary behaviours,[1,4] which is also associated with detrimental health and psychosocial outcomes.[8]

According to recent research, children who spend more time outdoors accumulate more daily moderate-to-vigorous physical activity (MVPA) and less sedentary time.[9-13] In a systematic review,[13] all eligible studies found positive associations between time outdoors and physical activity. However, because of reliance on convenience samples that are not representative of the population, the generalizability of these findings is uncertain. Moreover, few studies investigated whether outdoor time is associated with health indicators such as body composition, strength, and cardiovascular disease risk factors.[13]

The importance of play in children's development has been recognized in the United Nations' Convention on the Rights of the Child.[14] A number of studies,[15-18] have emphasized the role of unstructured outdoor play in physical, emotional, social, and cognitive well-being, and evidence suggests that outdoor play is helpful in the management of attention-deficit/hyperactivity disorder.[19,20] Other research has found that exposure to natural settings can contribute to children's resilience and cognitive functioning.[21,22] However, associations between outdoor time and psychosocial health have not been investigated in a population-based sample of school-aged children.

The present study examines the relationship between time outdoors and physical activity, sedentary time, and physical and psychosocial health among 7- to 14-year-olds who participated in the 2012/2013 Canadian Health Measures Survey (CHMS). It was hypothesized that more outdoor time would be associated with increased physical activity, less sedentary time, and more favourable physical and psychosocial health.

Data and methods

Data source

The CHMS is an ongoing Statistics Canada survey of household residents aged 3 to 79 in the ten provinces. About 96% of Canadians are represented. The survey excludes persons living in the three territories; persons living on reserves and in other Aboriginal settlements in the provinces; full-time members of the Canadian Forces; the institutionalized population; and residents of certain remote regions.

The CHMS involves an interview in the respondent's home and direct physical measures at a mobile examination centre.[23-26] Cycle 3 was the first to contain questions about chil-

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dren's outdoor time. Data collection took place from January 2012 through December 2013 at 16 sites in five regions (Atlantic, Quebec, Ontario, Prairies, and British Columbia). The mobile examination centre spent five to seven weeks at each location. Data were collected from around 350 respondents per site. A detailed description of data collection procedures, screening guidelines, and eligibility criteria for the various measurements is available in the online Data User's Guide.[27]

Ethics approval for the CHMS was obtained from Health Canada's Research Ethics Board.[24] Informed consent was obtained from a parent (or guardian), and written assent was obtained from all participating children.

Of the selected households, 74.1% agreed to participate. Among the recruited households, 90.5% of 7- to 14-years olds completed the questionnaire, 79.2% of whom participated in the mobile examination centre component. The overall response rate was 53.2%. Survey weights were created to take non-respondents' characteristics into account.

The present analyses are based on data from 1,159 participants aged 7 to 14 (48.6% female). Children who did not attend school in the previous month (n = 109) were excluded because questions about outdoor time before and after school do not apply to them; the majority of these children participated in the survey in August or September. A parent or guardian responded to the questions on behalf of children younger than 12; older children responded themselves.

For weekdays, participants reported outdoor time for four periods of the day: before school, at school, after school, and after dinner. For each period, they were asked: "During the past month, on an average school day, how much time did you usually spend outside [...]?" The response options were: none; 1 to less than 15 minutes; 15 to less than 30 minutes; 30 minutes to less than 1 hour; 1 to less than 2 hours; and 2 hours or more.

Using the same response options, weekend outdoor time was assessed: "On an average day during the past month, when you did not go to school, for example, on the weekend, how much time did you usually spend outside?"

After the mobile examination centre visit, participants were asked to wear an Actical accelerometer (Phillips – Respironics, Oregon, USA) on an elasticized belt over their right hip during waking hours for seven consecutive days. The Actical has been validated for measuring physical activity in children and youth.[28,29] Data were collected in 60-second epochs. Accelerometry data were available for 891 participants (76.9% of the total sample).

Specialists certified by the Canadian Society for Exercise Physiology conducted the grip strength tests and body composition measures.[30] Grip strength was measured twice with each hand with a Smedley III dynamometer (Takei Scientific Instruments, Japan); maximal scores for each hand were combined. Body mass index (BMI; kg/m^2) was computed from height and weight measured to the nearest 0.1 cm and 0.1 kg, respectively. Height was measured using a ProScale M150 digital stadiometer (Accurate Technology Inc., Fletcher, USA), and weight, with a Mettler Toledo VLC with Panther Plus terminal scale (Mettler Toledo Canada, Mississauga, Canada). Waist circumference was measured to the nearest 0.1 cm at the end of a normal expiration at the highest point of the iliac crest in accordance with the National Institutes of Health protocol.[31]

Blood pressure was measured with an automated monitor.[32] Six measurements were taken at one-minute intervals; average systolic and diastolic blood pressure were calculated from the last five measurements. Blood samples were taken by certified phlebotomists and analyzed at the Health Canada Laboratory.[23] The blood markers examined in the present analyses were: high-density lipoprotein (HDL) cholesterol, total cholesterol, total cholesterol/HDL ratio, and glycohemoglobin.

To assess psychosocial health, a parent (or guardian) of the child was asked to complete the Strengths and Difficulties Questionnaire (SDQ),[33,34] which has been extensively used in epidemiological studies. The psychometric properties of SDQ scores are described elsewhere.[34] The SDQ consists of 25 items divided into five subscales representing emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behaviour. A total difficulties score can be created by summing the subscales (excluding prosocial behaviour). On each subscale, children were classified as normal, borderline, or abnormal following standard procedures (http://www.sdqinfo.org/py/sdqinfo/c0.py). Because of small cell sizes, the borderline and abnormal groups were combined for analysis.

A four-step process was applied to estimate outdoor time in hours per day. First, the midpoint of each response option was used to provide a unique value for outdoor time in each period of the day (before school, at school, after school, and after dinner). The midpoint values were: 0 minutes (none); 7.5 minutes (1 to less than 15 minutes); 22.5 minutes (15 to less than 30 minutes); 45 minutes (30 minutes to less than 1 hour); 90 minutes (1 to less than 2 hours); and 150 minutes (2 hours or more). Second, outdoor time on weekdays was calculated by adding the values for the four periods of the day. Third, outdoor time in minutes per week was calculated as: (5 * outdoor time on weekdays) + (2 * outdoor time on weekend days). Fourth, to obtain hours per day, the result was divided by the constant 420 (that is, 60 minutes * 7 days).

Accelerometry data were treated as in Colley et al.[1,35] A valid day was defined as 10 or more hours of wear time; participants with at least four valid days (weekday or weekend) were included in the accelerometry subsample (n = 891). Daily wear time was obtained by subtracting non-wear time (periods of 60 or

more minutes of consecutive zero counts) from 24 hours. The cut-points to determine physical activity intensity were: less than 100 counts per minute = sedentary; 100 to 1,499 counts per minute = light physical activity; and 1,500 or more counts per minute = MVPA.[35] Given their skewed distributions, grip strength, BMI, waist circumference, and total cholesterol/HDL cholesterol ratio were transformed into their natural logarithms.

Statistical analyses

A series of t-tests was performed to compare outcomes of included and excluded participants. Multivariable linear regression analyses controlling for age, sex, and parent-reported household income and parental education were used to assess the relationship between outdoor time and the accelerometry measures (light physical activity, MVPA, daily step counts, and sedentary time) and physical health indicators. Logistic regression models were used to predict the likelihood of children being classified as borderline or abnormal based on the SDQ scales. These models were adjusted for age, sex, parental education and household income.

All analyses were performed with the Statistical Analysis System version 9.2 (Cary, North Carolina) using survey weights. To account for the complex survey design, 95% confidence intervals were estimated with the bootstrap technique,[36] and degrees of freedom were set to 11. Bonferroni adjustments were used, given the multiple comparisons; the adjusted alpha values are shown below

Table 1
Selected characteristics of children who attended school in past month, by sex, household population aged 7 to 14, Canada excluding territories, 2012/2013

	Total (n = 1,159)			Boys (n = 596)			Girls (n = 563)		
		95% confidence interval			95% confidence interval			95% confidence interval	
Characteristics	Mean or %	from	to	Mean or %	from	to	Mean or %	from	to
Age (years)	10.6	10.4	10.9	10.6	10.3	10.9	10.7	10.4	11.1
Parental education (%)									
Less than college	14.7	10.8	18.6	15.3	10.1	20.4	14.1[E]	7.8	20.4
College	34.1	27.6	40.6	30.3	22.6	37.9	38.1	30.2	45.9
University	47.3	37.7	56.9	49.7	40.5	59.0	44.9	33.7	56.0
Household income (%)									
Less than $40,000	23.0[E]	13.0	32.9	25.4[E]	13.9	36.9	20.5[E]	11.0	30.0
$40,000 to $79,999	30.0	21.8	38.7	32.9	22.6	43.3	26.9	16.6	37.2
$80,000 or more	47.1	37.3	56.9	41.7	29.7	53.7	52.6	41.0	64.2
Time outdoors									
Total (hours/day)	2.3	2.0	2.5	2.4	2.1	2.7	2.1	1.8	2.5
Before school (minutes/day)	8.5	7	10	8.7	7	11	8.3	7	10
At school (minutes/day)	62.4	57	68	64.2	59	69	60.6	54	68
After school (minutes/day)	43.8	35	52	46.3	33	59	39.2	30	48
After dinner (minutes/day)	30.5	22	39	32.6	23	42	28.3	18	39
Physical activity and health-related outcomes									
Sedentary (minutes/day)	500	492	508	497	486	509	504	489	518
Light physical activity (minutes/day)	253	245	261	254	244	263	252	243	261
Moderate-to-vigorous physical activity (minutes/day)	59	52	66	67	57	77	52	46	57
Steps/day	11,301	10,444	12,159	12,139	10,946	13,333	10,500	9,798	11,202
Body mass index (BMI) (kg/m^2)	19.2	18.5	20.0	19.5	18.4	20.5	19.0	18.2	19.8
Waist circumference (cm)	67.5	65.3	69.8	68.0	65.2	70.7	67.1	64.5	69.6
Grip strength (kg)	37.2	35.2	39.1	39.8	37.2	42.5	34.4	32.4	36.5
Systolic blood pressure (mmHg)	94.9	94.1	95.7	94.8	93.3	96.3	95.0	93.3	96.7
Diastolic blood pressure (mmHg)	61.5	60.7	62.4	61.4	60.2	62.5	61.7	60.1	63.4
High-density lipoprotein (HDL) cholesterol (mmol/L)	1.4	1.4	1.5	1.4	1.4	1.5	1.4	1.4	1.5
Total cholesterol (mmol/L)	4.0	3.9	4.2	4.0	3.8	4.2	4.1	4.0	4.2
Total cholesterol/HDL (mmol/L)	3.0	2.9	3.1	2.9	2.8	3.1	3.0	2.9	3.1
Glycohemoglobin (%)	5.2	5.1	5.3	5.2	5.1	5.3	5.2	5.1	5.3
Strengths and difficulties (% borderline/abnormal)									
Emotional symptoms	20.8	15.0	26.6	13.5[E]	6.4	20.7	28.3	20.5	36.0
Conduct problems	12.8	9.2	16.3	15.1	9.7	20.6	10.3[E]	4.3	16.4
Hyperactivity/Inattention	19.2	14.5	24.0	22.2	16.1	28.4	16.1[E]	9.0	23.2
Peer relationship problems	14.0	9.2	18.7	12.3[E]	7.3	17.3	15.6[E]	8.4	22.9
Prosocial behaviour	4.3[E]	2.0	6.5	7.1[E]	2.8	11.3	F	F	F
Total difficulties score	14.5	10.0	19.1	14.2	10.4	18.0	14.9[E]	6.4	23.4

[E] use with caution
F too unreliable to be published
Source: 2012/2013 Canadian Health Measures Survey.

the tables. Models stratified by sex are provided for the physical activity and health indicators. For the SDQ scales, because of the small number of children classified as borderline/abnormal, models are provided only for the overall sample. Supplementary analyses examined relationships between outdoor time and physical activity and health indicators before school, at school, after school, and after dinner.

Results

Descriptive characteristics of the sample are shown by sex in Table 1. No statistically significant differences for any outcome were found between those who provided valid accelerometry data and those who did not. On average, 7- to 14-year-olds reported 2.3 hours a day outdoors and accumulated 59 minutes a day of MVPA. The majority were classified as "normal" on the SDQ subscales.

Each additional hour outdoors per day was associated with an extra 7 minutes of MVPA, 762 more steps, and 13 fewer minutes of sedentary time (Table 2). Estimates were similar for boys and girls, although some associations were no longer significant in the sex-stratified models. Outdoor time was not associated with any measure of physical health (Table 3).

With each additional hour outdoors per day, the odds of a borderline/abnormal score on the peer relationships problem SDQ subscale or on the total difficulties score were 31% and 22% lower, respectively (Table 4). No differences were apparent on the other subscales.

Analyses of time outdoors at different periods of the day indicated fewer differences (Appendix Tables A, B and C). Nevertheless, each 15 minutes outdoors after school per day was associated with 19% lower odds of a borderline/abnormal score on the peer relationship problems subscale. Each 15 minutes outdoors after dinner per day was associated with an additional 1.9 minutes of MVPA, 199 more steps, and 4 fewer minutes of sedentary time.

Discussion

This study examined relationships between reported outdoor time, objectively measured physical activity and sedentary time, and several measures of physical and psychosocial health in a nationally representative sample of 7- to 14-year-olds. Consistent with the hypothesis, outdoor time was strongly associated with MVPA, step counts, and sedentary time; the magnitude of these

Table 2
Regression coefficients relating time outdoors to physical activity and sedentary time, by sex, household population aged 7 to 14, Canada excluding territories, 2012/2013

	Total (n = 891)				Boys (n = 453)				Girls (n = 438)			
		95% confidence interval				95% confidence interval				95% confidence interval		
Activity level	b	from	to	p	b	from	to	p	b	from	to	p
Sedentary (minutes day)	-13.1	-21.0	-5.2	0.004[†]	-12.3	-21.3	-3.3	0.012[†]	-14.6	-27.5	-1.7	0.030
Light physical activitiy (minutes/day)	4.6	-2.1	11.2	0.158	6.4	-2.8	15.7	0.156	4.5	-2.3	11.3	0.174
Moderate-to-vigorous physical activity (minutes/day)	7.0	3.4	10.7	0.001[†]	7.8	2.0	13.6	0.013	6.6	3.0	10.2	0.002[†]
Steps/day	762	368	1,155	0.001[†]	963	267	1,658	0.011[†]	656	106	1,205	0.024

[†] significant difference after Bonferroni adjustment ($p < 0.0125$)
Note: Data are presented as unstandardized regression coefficients for each additional hour outdoors per day.
Source: 2012/2013 Canadian Health Measures Survey.

Table 3
Regression coefficients relating time outdoors to measures of physical health, by sex, household population aged 7 to 14, Canada excluding territories, 2012/2013

Measures of physical health	Total (n = 1,159)				Boys (n = 596)				Girls (n = 563)			
		95% confidence interval				95% confidence interval				95% confidence interval		
	b	from	to	p	b	from	to	p	b	from	to	p
Log of body mass index (BMI) (kg/m^2)	0.01	-0.01	0.03	0.25	0.01	-0.01	0.04	0.33	0.01	-0.02	0.03	0.55
Log of waist circumference (cm)	0.01	-0.01	0.02	0.33	0.00	-0.02	0.02	0.65	0.01	-0.01	0.02	0.50
Log of grip strength (kg)	0.01	-0.02	0.05	0.35	0.00	-0.04	0.03	0.94	0.03	-0.01	0.07	0.11
Systolic blood pressure (mmHg)	0.19	-0.43	0.81	0.51	-0.27	-1.12	0.59	0.51	0.49	-0.72	1.69	0.39
Diastolic blood pressure (mmHg)	0.09	-0.64	0.81	0.79	-0.32	-1.33	0.68	0.49	0.60	-0.51	1.71	0.26
High-density lipoprotein (HDL) cholesterol (mmol/L)	0.00	-0.03	0.02	0.78	0.01	-0.04	0.05	0.72	0.00	-0.05	0.04	0.83
Total cholesterol (mmol/L)	-0.01	-0.11	0.09	0.81	-0.01	-0.15	0.13	0.89	-0.02	-0.10	0.05	0.52
Log of total cholesterol/HDL	0.00	-0.03	0.02	0.86	-0.01	-0.04	0.03	0.63	-0.01	-0.04	0.03	0.71
Glycohemoglobin (%)	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.20

Notes: Data are presented as unstandardized regression coefficients for each additional hour outdoors per day. After a Bonferroni adjustment, α was set at $p < 0.0055$. BMI, waist circumference, grip strength, and ratio total cholesterol/HDL cholesterol were transformed into their natural logarithms.
Source: 2012/2013 Canadian Health Measures Survey.

Table 4
Odds ratios relating time outdoors to measures of psychosocial health, household population aged 7 to 14, Canada excluding territories, 2012/2013

Measures of psychosocial health	Odds ratio	95% confidence interval from	to	p
Emotional symptoms	0.95	0.70	1.29	0.72
Conduct problems	0.92	0.65	1.30	0.59
Hyperactivity/Inattention	0.92	0.79	1.08	0.30
Peer relationship problems	0.69	0.53	0.90	0.01†
Prosocial behaviour	0.73	0.37	1.46	0.35
Total difficulties score	0.78	0.65	0.93	0.01†

† significant difference after Bonferroni adjustment ($p < 0.01$)
Note: Data are presented as odds ratios for each additional hour outdoors per day.
Source: 2012/2013 Canadian Health Measures Survey.

associations was similar for both sexes. Outdoor time was not related to objective measures of physical health, but children who reported more time outdoors were less likely to have peer relationship problems, and they had better psychosocial health.

Other investigators have found time outdoors to be associated with higher MVPA and less sedentary time.[9-13] The present study extends the evidence base by demonstrating similar relationships in a nationally representative sample. Given that only 9% of children and youth in this sample met the Canadian physical activity guideline of 60 minutes of MVPA a day (data not shown), encouraging outdoor time might increase compliance.

Outdoor time after dinner was associated with more physical activity and less sedentary time. This supports the contention that unstructured outdoor activities after school offer an opportunity to increase children's physical activity.[37] Other studies have found similar relationships for the after-school period,[10-12,38] although the definition of "after school" varied across studies.

The present analysis revealed no associations between outdoor time and measures of physical health. It is possible that many outdoor activities are not sufficiently intense to have immediate health effects. A similar argument has been advanced to explain the lack of significant relationships between walking for transportation and cardiovascular disease risk factors in children and youth.[39,40] Inconsistent findings in previous studies of the relationship between outdoor time and blood pressure[11,41] or adiposity[9-11] in school-aged children may be due, in part, to methodological differences between studies. The inconsistent results in the literature suggest a need for more research in this area.

Children reporting more time outdoors were less likely to be classified as borderline/abnormal on the peer relationship problems subscale and the total difficulties score of the SDQ. Unstructured outdoor play with peers, siblings, and parents may help children develop better social skills and enhance their ability to cooperate, self-regulate, and solve problems.[15,18] This reasoning is supported by two small forest school interventions in which improved mood was observed among children who received classes in outdoor wooded areas.[42,43] Furthermore, given that children are more active while outdoors[13] and that physical activity is associated with enhanced mental health,[44] it may be hypothesized that physical activity acts as a mediator of the relationship between outdoor time and psychosocial indicators. This hypothesis could not be tested with CHMS data because the reference period for the outdoor time question (last month) differed from the physical activity measurement period (7 days). On the other hand, it is possible that children who have more friends and better social skills may be more likely to play outside; hence, longitudinal studies are needed to determine the direction of the relationship between outdoor play and psychosocial health.

What is already known on this subject?

- A systematic review concluded that children who spend more time outdoors are more active overall.
- No nationally representative study has examined relationships between time outdoors and indicators of physical and psychosocial health in school-aged children.

What does this study add?

- Among a nationally representative sample of 7- to 14-year-olds, each additional hour outdoors per day was associated with less sedentary time, more steps per day, and more moderate-to-vigorous physical activity.
- Children who spent more time outdoors were less likely to have peer relationship problems and had better psychosocial health.
- Future experimental studies might examine whether increasing time outdoors leads to more physical activity and enhanced mental health among school-aged children.

Unlike studies of children diagnosed with attention-deficit/hyperactivity disorder,[19,20] these analyses showed no association between time spent outdoors and hyperactivity/inattention as assessed with the SDQ. However, the present study examined the population as a whole, not children with diagnosed mental health disorders.

Strengths and limitations

This is the first nationally representative investigation of the relationship between outdoor time and measures of physical activity, sedentary time, and health in school-aged children. It benefits from a large sample size, direct measures of health indicators, and the use of the

validated SDQ. The objective measures of physical activity and sedentary time minimized social desirability and recall biases associated with physical activity questionnaires.[45]

The main limitation is the cross-sectional design of the CHMS, which precludes causal inferences. In addition, the use of predetermined categories to quantify the amount of outdoor time may have created a ceiling effect, particularly for weekend days. The reliability and validity of the outdoor time questions is unknown and should be assessed in future studies Nevertheless, inaccuracies in reports of outdoor time should bias the results toward the null hypothesis. The difference in reference periods for the outdoor time questions and for accelerometry measurement, as well as accelerometers' shortcomings in capturing activities such as cycling and swimming, could also bias the results toward the null hypothesis.

The design of the CHMS provided only 11 degrees of freedom, thereby limiting the ability to control for potential confounders. Finally, given the travel costs associated with the mobile examination center, the CHMS was not designed to examine seasonality. This may be a confounder because children tend to be less active in the winter[46] and likely spend less time outdoors. Future studies of relationships between outdoor time, physical activity, sedentary time, and health indicators should control for seasonality.

Conclusion

Children who report more time outdoors are more physically active and less sedentary, and display enhanced psychosocial health, compared with those who spend less time outdoors. Research on the correlates of outdoor time is warranted. For instance, some studies suggest that improving neighbourhood social cohesion may encourage outdoor activities by alleviating parental safety concerns.[47-49] The role of factors such as the physical environment and family size could be further investigated. Finally, longitudinal analyses could examine relationships between objectively measured outdoor time (for example, using a combination of time-stamped accelerometers and global positioning systems) and health indicators. ■

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Appendix

Table A

Regression coefficients relating time outdoors to physical activity and sedentary time, by sex and period of day, household population aged 7 to 14, Canada excluding territories, 2012/2013

	Total (n = 891)				Boys (n = 453)				Girls (n = 438)			
		95% confidence interval				95% confidence interval				95% confidence interval		
Period of day and activity level†	b	from	to	p	b	from	to	p	b	from	to	p
Before school												
Sedentary (minutes/day)	-0.5	-1.0	0.1	0.097	-0.4	-1.2	0.5	0.339	-0.5	-1.6	0.5	0.268
Light physical activity (minutes/day)	0.3	-0.1	0.7	0.181	0.2	-0.4	0.8	0.440	0.2	-0.7	1.1	0.584
Moderate-to-vigorous physical activity (minutes/day)	0.2	0.0	0.4	0.025	0.3	-0.1	0.6	0.127	0.1	-0.2	0.4	0.431
Steps/day	11.0	-19.0	42.0	0.432	5.0	-43.0	53.0	0.809	25.0	-27.0	78.0	0.313
At school												
Sedentary (minutes/day)	0.0	-0.2	0.1	0.685	-0.1	-0.4	0.3	0.660	0.0	-0.3	0.2	0.842
Light physical activity (minutes/day)	0.0	-0.3	0.2	0.661	0.0	-0.3	0.3	0.748	0.0	-0.2	0.2	0.917
Moderate-to-vigorous physical activity (minutes/day)	0.1	0.0	0.1	0.213	0.1	-0.1	0.2	0.401	0.1	0.0	0.2	0.198
Steps/day	6.0	-6.0	19.0	0.292	8.0	-17.0	33.0	0.491	8.0	-3.0	19.0	0.152
After school												
Sedentary (minutes/day)	-0.2	-0.5	0.1	0.250	-0.1	-0.5	0.3	0.495	-0.2	-0.8	0.3	0.325
Light physical activity (minutes/day)	0.1	-0.1	0.2	0.519	0.1	0.0	0.3	0.098	0.0	-0.2	0.2	0.964
Moderate-to-vigorous physical activity (minutes/day)	0.1	0.0	0.2	0.027	0.2	0.0	0.3	0.078	0.1	0.0	0.2	0.038
Steps/day	16.0	0.0	32.0	0.053	23.0	-1.0	46.0	0.055	10.0	-3.0	23.0	0.128
After dinner												
Sedentary (minutes/day)	-0.3	-0.4	-0.1	0.006†	-0.3	-0.4	-0.1	0.012†	-0.3	-0.5	0.0	0.034
Light physical activity (minutes/day)	0.1	0.0	0.2	0.017	0.2	0.0	0.3	0.027	0.1	0.0	0.3	0.071
Moderate-to-vigorous physical activity (minutes/day)	0.1	0.0	0.2	0.011†	0.1	0.0	0.2	0.077	0.1	0.0	0.3	0.024
Steps/day	13.0	5.0	22.0	0.006†	16.0	5.0	27.0	0.007†	12.0	-3.0	27.0	0.113

† significant differences after Bonferroni adjustment ($p < 0.0125$)

Note: Data are presented as unstandardized regression coefficients for each additional minute outdoors per day.

Source: 2012/2013 Canadian Health Measures Survey.

Table B
Regression coefficients relating time outdoors to measures of physical health, by sex and period of day, household population aged 7 to 14, Canada excluding territories, 2012/2013

	Total (n = 1,159)				Boys (n = 596)				Girls (n = 563)			
		95% confidence interval				95% confidence interval				95% confidence interval		
Period of day and measure of physical health	b	from	to	p	b	from	to	p	b	from	to	p
Before school												
Log of body mass index (BMI) (kg/m²)	0.00	0.00	0.00	0.55	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.80
Log of waist circumference (cm)	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.89	0.00	0.00	0.00	0.14
Log of grip strength (kg)	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.77	0.00	0.00	0.00	0.64
Systolic blood pressure (mmHg)	0.02	-0.07	0.12	0.62	0.03	-0.08	0.14	0.56	0.01	-0.10	0.13	0.82
Diastolic blood pressure (mmHg)	0.00	-0.08	0.08	0.96	0.01	-0.10	0.12	0.85	-0.01	-0.12	0.09	0.81
High-density lipoprotein (HDL) cholesterol (mmol/L)	0.00	-0.01	0.00	0.34	0.00	0.00	0.00	0.43	0.00	-0.01	0.00	0.29
Total cholesterol (mmol/L)	0.00	-0.01	0.00	0.51	-0.01	-0.01	0.00	0.10	0.00	-0.01	0.01	0.73
Log of total cholesterol/HDL	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.36
Glycohemoglobin (%)	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.04
At school												
Log of body mass index (BMI) (kg/m²)	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.39
Log of waist circumference (cm)	0.00	0.00	0.00	0.62	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.44
Log of grip strength (kg)	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.02
Systolic blood pressure (mmHg)	-0.01	-0.03	0.02	0.48	0.01	-0.02	0.04	0.58	-0.02	-0.07	0.03	0.36
Diastolic blood pressure (mmHg)	-0.01	-0.04	0.02	0.56	0.01	-0.02	0.04	0.52	-0.02	-0.07	0.02	0.25
High-density lipoprotein (HDL) cholesterol (mmol/L)	0.00	0.00	0.00	0.98	0.00	0.00	0.00	0.84	0.00	0.00	0.00	0.89
Total cholesterol (mmol/L)	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.44	0.00	-0.01	0.00	0.10
Log of total cholesterol/HDL	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.62	0.00	0.00	0.00	0.19
Glycohemoglobin (%)	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.55
After school												
Log of body mass index (BMI) (kg/m²)	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.37
Log of waist circumference (cm)	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.11
Log of grip strength (kg)	0.00	0.00	0.00	0.89	0.00	0.00	0.00	0.38	0.00	0.00	0.00	0.55
Systolic blood pressure (mmHg)	0.00	-0.02	0.02	0.67	0.00	-0.03	0.02	0.72	0.01	-0.02	0.03	0.47
Diastolic blood pressure (mmHg)	0.01	-0.01	0.02	0.54	0.01	-0.03	0.03	0.98	0.01	-0.01	0.03	0.38
High-density lipoprotein (HDL) cholesterol (mmol/L)	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.35
Total cholesterol (mmol/L)	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.92	0.00	0.00	0.00	0.41
Log of total cholesterol/HDL	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.86
Glycohemoglobin (%)	0.00	0.00	0.00	0.92	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.75
After dinner												
Log of body mass index (BMI) (kg/m²)	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.41	0.00	0.00	0.00	0.59
Log of waist circumference (cm)	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.24
Log of grip strength (kg)	0.00	0.00	0.00	0.59	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.51
Systolic blood pressure (mmHg)	0.02	-0.01	0.04	0.14	0.00	-0.03	0.03	0.97	0.03	-0.01	0.06	0.16
Diastolic blood pressure (mmHg)	0.01	-0.01	0.03	0.45	-0.01	-0.04	0.01	0.34	0.03	-0.01	0.07	0.16
High-density lipoprotein (HDL) cholesterol (mmol/L)	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.89	0.00	0.00	0.00	0.98
Total cholesterol (mmol/L)	0.00	0.00	0.00	0.83	0.00	0.00	0.00	0.77	0.00	0.00	0.00	0.96
Log of total cholesterol/HDL	0.00	0.00	0.00	0.63	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.84
Glycohemoglobin (%)	0.00	0.00	0.00	0.91	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.29

Notes: Data are presented as unstandardized regression coefficients for each additional minute outdoors per day. After a Bonferroni adjustment, α was set at $p < 0.0055$. BMI, waist circumference, grip strength, and ratio total cholesterol/HDL cholesterol were transformed into their natural logarithms.
Source: 2012/2013 Canadian Health Measures Survey.

Table C
Odds ratios relating time outdoors to measures of psychosocial health, by period of day, household population aged 7 to 14, Canada excluding territories, 2012/2013

Period of day and measures of psychosocial health	Odds ratio	95% confidence interval		p
		from	to	
Before school				
Emotional symptoms	0.98	0.95	1.01	0.13
Conduct problems	0.99	0.97	1.02	0.70
Hyperactivity/inattention	1.00	0.98	1.02	0.85
Peer relationship problems	1.01	0.99	1.04	0.27
Prosocial behaviour	1.01	0.90	1.13	0.87
Total difficulties score	1.00	0.98	1.03	0.77
At school				
Emotional symptoms	1.00	0.99	1.01	0.79
Conduct problems	1.00	0.99	1.01	0.86
Hyperactivity/inattention	1.00	0.99	1.01	0.66
Peer relationship problems	1.00	1.00	1.01	0.36
Prosocial behaviour	1.00	0.98	1.02	0.82
Total difficulties score	1.00	0.99	1.01	0.91
After school				
Emotional symptoms	1.00	0.99	1.01	0.83
Conduct problems	1.00	0.99	1.01	0.86
Hyperactivity/inattention	1.00	1.00	1.01	0.79
Peer relationship problems	0.99	0.98	0.99	<0.01†
Prosocial behaviour	1.00	0.97	1.02	0.64
Total difficulties score	0.99	0.99	1.00	0.05
After dinner				
Emotional symptoms	1.00	0.99	1.01	0.92
Conduct problems	1.00	0.99	1.01	0.48
Hyperactivity/inattention	1.00	0.99	1.00	0.25
Peer relationship problems	0.99	0.98	1.00	0.05
Prosocial behaviour	0.99	0.97	1.01	0.46
Total difficulties score	1.00	0.99	1.00	0.17

† significant difference after Bonferroni adjustment ($p < 0.01$)
Note: Data are presented as odds ratios for each additional minute outdoors per day.
Source: 2012/2013 Canadian Health Measures Survey.